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APTD-0772

PB 203 953

TAX SYSTEMS TO SUPPORT REDUCTION OF LEAD CONTENT IN MOTOR GASOLINES

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BIBLIOGRAPHIC DATA SHEET	1. Report No. APTD-0772	2.	3. Recipient's Accession No.
4. Title and Subtitle Tax Systems to Support Reduction of Lead Content in Motor Gasolines			5. Report Date July 29, 1971 6.
7. Author(s)			8. Performing Organization Rept. No. RGH-018
9. Performing Organization Name and Address Bonner & Moore Associates, Incorporated 500 Jefferson Building Houston, Texas 77002			10. Project/Task/Work Unit No. 11. Contract/Grant No. EPA 68-02-0050-3
12. Sponsoring Organization Name and Address Environmental Protection Agency Office of Air Programs Research Triangle Park, North Carolina 27711			13. Type of Report & Period Covered 14.

15. Supplementary Notes DISCLAIMER- This report was furnished to the Office of Air Programs by Bonner & Moore Associates, Incorporated, 500 Jefferson Building, Houston, Texas 77002 in fulfillment of 68-02-0050-3

16. Abstracts

A description and interpretation is presented of a study which was conducted to evaluate various tax systems for possible use in supporting federal regulations governing the content of lead alkyl (primarily tetraethyl lead) in motor gasolines. Four schedules were selected for further analysis to explore the use of taxation as an implementation device. The study presents a section on study methodology and study results.

17. Key Words and Document Analysis. 17a. Descriptors

Air pollution
Exhaust emission
Vehicles
Gasoline
Tetraethyl lead
Lead organic compounds
Removal
Taxes
Expenses
Consumers

17b. Identifiers/Open-Ended Terms

Air pollution control

17c. COSATI Field/Group 13B, 21D

18. Availability Statement Unlimited.	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 73
	20. Security Class (This Page) UNCLASSIFIED	22. Price

FORM NTIS-35 (10-70)

USCOMM-DC 40329-P71

TAX SYSTEMS TO SUPPORT REDUCTION OF LEAD CONTENT IN MOTOR GASOLINES

Prepared for the Environmental Protection Agency under Contract Number 68-02-0050-3.

29 July 1971

RGH-018

TABLE OF CONTENTS

Paragraph		Page
	SECTION 1	
	INTRODUCTION	
1.1	PURPOSE	1-1
1.2	BACKGROUND	1-1
	1.2.1 The Added Cost Study	1-1
	1.2.2 Selection of Schedules for Tax Study	1-4
1.3	BASIS FOR TAX STUDY	1-5
1.4	STUDY OBJECTIVES	1-7
1.5	STUDY PREMISES	1-8
1.6	EPA SCHEDULES STUDIED	1-10
	SECTION 2	
	CONCLUSIONS	
2.1	GENERAL	2-1
2.2	EFFECTS OF TAX ON GASOLINE CONTAINING LEAD	2-3
2.3	EFFECTS OF DIRECT TAX ON LEAD	2-5
2.4	EFFECT ON CONSUMER	2-9

TABLE OF CONTENTS (cont.)

Paragraph		Page
	SECTION 3	
	STUDY METHODOLOGY	
3.1	STUDY ASSUMPTIONS	3-1
3.1.1	Schedules Studied	3-1
3.1.2	Incremental Manufacturing Costs	3-2
3.1.3	Two-Sector Model	3-3
3.2	PUMP PRICE CALCULATION	3-5
3.2.1	Pump Price Spread Definition	3-5
3.2.2	Calculating Price Spreads	3-5
3.2.3	Calculating Price at the Pump	3-8
3.3	TAX STRATEGIES	3-15
3.3.1	Tax on Gasoline Containing Lead	3-15
3.3.2	Flat Tax Per Pound of Lead Used in Additives	3-15
3.3.3	Calculated Revenue From Tax	3-15
3.3.4	Calculation of Average Distribution Costs	3-16

TABLE OF CONTENTS (cont.)

Paragraph		Page
	SECTION 4	
	STUDY RESULTS	
4.1	TAX ON GASOLINE CONTAINING LEAD	4-1
	4.1.1 Schedule A Results	4-1
	4.1.2 Schedule O and N Results	4-5
	4.1.3 Schedule L Results	4-8
4.2	TAX ON LEAD	4-10
	4.2.1 Schedule A Results	4-10
	4.2.2 Schedules O, N and L Results	4-10
4.3	TAX VERIFICATION - TWO-SECTOR MODEL	4-16
	4.3.1 Two Sector Results, Tax On Gasoline Containing Lead	4-18
	4.3.2 Two Sector Results, Tax On Lead	4-23
4.4	SMALL REFINERS	4-26
4.5	TAX RATE SUMMARY	4-27

LIST OF ILLUSTRATIONS

Figure		Page
1-1	Octane Improvement of Gasoline	1-5
1-2	Octane Improvement of Gasoline	1-6
2-1	Octane Improvement versus Amount of Lead Used	2-6
2-2	Percent Lead Reduction versus Lead Tax	2-8
3-1	Incremental Manufacturing Cost Differences versus Pump Price Spread	3-7
4-1	Lead Removal versus Lead Cost for Two Typical Refineries	4-26

LIST OF TABLES

Table		Page
1	NATIONAL DEMAND FORECAST FOR GASOLINE	1-9
2	SCHEDULED LEAD LEVELS AND PERCENT LEAD REDUCTION FROM 1971 BASE	1-11
3	SCHEDULE A TAX RATES	2-4
4	DIRECT TAX ON LEAD ADDITIVES FOR SCHEDULES O, N, AND L	2-5
5	RELATIVE SERVICE STATION PUMP PRICES	2-10
6	INCREMENTAL MANUFACTURING COST ABOVE CONVENTIONAL REGULAR (94 RON)	3-9
7	PUMP PRICE SPREAD ANALYSIS 93 AND 100 RON GRADES ABOVE LEADED 94 RON GRADE	3-10
8	SCHEDULE A - TAX ON GASOLINE CONTAINING LEAD	4-3
9	SCHEDULE O AND N - TAX ON GASOLINE CONTAINING LEAD	4-7
10	MAXIMUM LEAD LEVEL REGULATION REQUIRED FOR ALL LEADED GASOLINE	4-8
11	SCHEDULE L, LEAD LEVELS AND OCTANE RATINGS	4-9
12	SCHEDULES O, N AND L TAX ON LEAD	4-11
13	TAX ON LEAD DOLLARS PER POUND + 0.5 CENTS/ GALLON TAX CREDIT FOR UNLEADED GASOLINE	4-13
14	REVENUE SENSITIVITY ANALYSIS (CUMULATIVE) TAX ON LEAD	4-14
15	SUMMARY OF MODEL VERIFICATION RUNS - 1974	4-17
16	SUMMARY OF TAX ON LEADED GASOLINE - 1974	4-21
17	SUMMARY OF TAX ON LEAD - 1974	4-24
18	AVERAGE LEAD LEVEL OF MOTOR GASOLINE	4-25
19	TAX RATES FOR SCHEDULES A, O, N, AND L	4-28

SECTION 1

INTRODUCTION

1.1 PURPOSE

The study described and interpreted in this document was conducted to evaluate various tax systems for possible use in supporting federal regulations governing the content of lead alkyl (primarily tetraethyl lead) in motor gasolines.

1.2 BACKGROUND

This study on tax systems extends an earlier study on the economic impact of lead reduction or removal according to various schedules. The economic study is fully described and interpreted in a separate report[1] and will be referenced in this document as the *Added Cost Study*. To achieve continuity, however, the early study is briefly reviewed in this report.

1.2.1 The Added Cost Study

The study of the economic impact of lead reduction or removal considered numerous schedules for reducing lead levels in gasoline during the years 1971 through 1980. Schedules were based on compliance with the Clean Air Act of 1970 and were drawn up by the federal Environmental Protection Agency (EPA) for examination.

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[1]"An Economic Analysis of Proposed Schedules for Removal of Lead Additives from Gasoline," prepared by Bonner & Moore Associates, Inc., for the Environmental Protection Agency, June, 1971.

The Added Cost Study examined the economics of lead reduction in today's conventional 94 (regular) and 100 (premium) octane gasolines which contain from 2 to 3 grams/gallon of lead additive. The economics of refining have become dependent on the use of lead for achieving octane appreciation of approximately 8 to 9 octane numbers in the U.S. gasoline pool. The use of lead additives has been a universal practice among gasoline refiners since the 1930s and remains today the most economical method for octane improvement. Achieving the same octane appreciation by any other method requires the processing of additional crude oil and the use of more complex processing equipment.

The objective of the Added Cost Study was analysis of lead reduction and removal schedules in order to assess the economic impact on:

1) The refining industry,

2) The petrochemical industry,

3) The refinery construction industry,

4) Gasoline distributors, and

5) Gasoline consumers.

Lead removal schedules envisioned the creation of a "new grade" of gasoline with an octane rating (at 93 octane) slightly below that for conventional regular gasoline (94 octane) but manufactured at low-lead (up to .5 grams/gallon) or no-lead levels. The Added Cost Study established that the

new grade's introduction would minimize added costs for lead reduction as estimated in an earlier analysis[2] which considered only the two conventional grades.

The Added Cost Study assumed that all cars manufactured in 1975 and later would use the new grade of gasoline. It also assumed that almost all cars built between 1971 and 1974 could use this new grade and that owners of these cars would buy conventional regular (leaded) and the new grade in a 50:50 ratio.

Demand projections based on these assumptions show demand for 100-octane (premium) gasoline peaking with the beginning of the 1971 model year, when car manufacturers lowered octane requirements, and continuing to diminish over an extended period as autos requiring premium gasoline are eliminated from the car population. Also, all lead emissions would be eliminated from automotive exhausts when the last pre-1975 automobiles are retired from service.

A year-by-year economic evaluation of these assumptions was conducted for the 10-year period between 1971 and 1980. Results were compared to a base case in which there was normal growth in fuel consumption and no restrictions on the use of lead in gasoline. Also included in the Added Cost Study were numerous other schedules designed to accelerate lead reduction in conventional grades of gasoline.

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[2]"U.S. Motor Gasoline Economics, Volume I", a report prepared from an analysis performed by Bonner & Moore for the American Petroleum Institute in March of 1967.

1.2.2 Selection of Schedules for Tax Study

Four schedules were selected from the Added Cost Study for further analysis to explore the use of taxation as an implementation device. Two of the schedules represented the fastest and slowest rates of lead reduction. The other two were intermediate schedules between these two extremes. Through interpolation, the effect of *taxation* on any three-grade schedule covered in the Added Cost Study can be derived.

All of the selected schedules required that the "new grade" of gasoline be manufactured at a low-lead (maximum 0.5 grams/gallon) until 1974. In 1974 and subsequent years of the schedule, the new grade would be lead-free. Differences between the schedules provided for removal of lead from conventional 94-octane and 100-octane grades at different rates over the 10-year period.

The slowest lead reduction schedule (Schedule A) allowed lead to remain at refinery economic levels in the leaded fuels (2 to 3 grams/gallon). Two other schedules (Schedules O and N) accelerated the rate of lead reduction by successively reducing the lead content in conventional grades. The fourth schedule (Schedule L) provided for complete lead removal from all grades by 1976.

1.3 BASIS FOR TAX STUDY

Current gasoline pricing policies generally reflect the cost of manufacture in the pump prices for gasoline. Such a practice does not provide consumer incentives for purchasing unleaded gasolines. Rather, it accomplishes exactly the opposite.

Pre-1971 automobiles will continue to require 94-octane and 100-octane conventional gasolines. Post-1971 automobiles are being designed to run on lower octane fuels--or the "new grade" gasoline--at 93 octane. The problem is that the new grade gasoline, despite lower octane, costs more to manufacture than 94-octane leaded regular. If pump prices reflect manufacturing costs, then many owners of the post-1971 cars will be inclined to use the cheaper, higher-octane fuel even though the higher octane is not required.

A lead-related tax (either a tax on lead or a tax on gasoline containing lead) could raise the price of leaded gasoline so that the price of the unleaded or low-leaded gasoline is competitive with the leaded regular. Under such a pricing structure, persons who do not require the leaded gasoline would be encouraged to buy the fuel that is appropriate for their automobiles.

Figure 1-1 is a simplified diagram illustrating the cost difference between octane improvement with lead and octane improvement through other component changes (manufacturing). A 93-octane

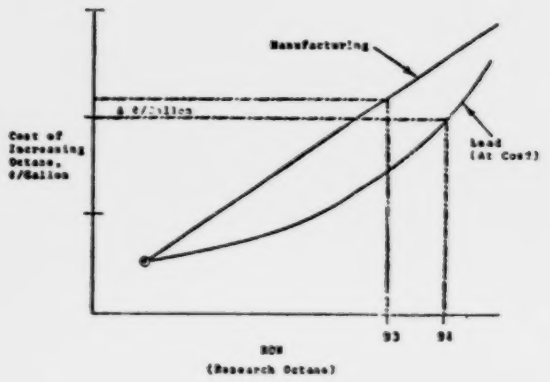

Figure 1-1. Octane Improvement of Gasoline

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gasoline may, in fact, be more costly to make than 94-octane gasoline if the lower-octane grade is required to be lead free.

A tax on gasoline containing lead could then minimize this cost difference as it is reflected at the service station pump. The assumption is that any manufacturing cost differences between various grades of motor gasolines will be magnified in the final pump prices.

Figure 1-2 illustrates the impact of a direct tax on lead. The cost of manufacturing the higher octane fuel (94-octane leaded) is brought up to the level of the 93-octane clear gasoline through imposition of a tax. Such a tax can be viewed as a disincentive for the purchase of leaded gasoline.

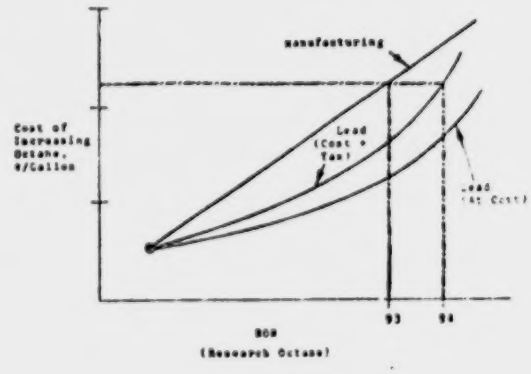

Figure 1-2. Octane Improvement of Gasoline

A tax on lead raises the cost of lead additives used in gasoline, making its use more expensive. The cost of using lead for octane improvement, with the tax burden, begins to approach the cost of octane improvement through manufacture. The effect of a tax on lead is shown in Figure 1-2 where the lead curve pivots on its point of origin. Not only will a tax on lead minimize the cost differential between leaded and unleaded regular gasolines, it will also cause the petroleum refiner to reduce the total amount of lead additive used.

A lead-related tax system (levied either on lead or on gasoline containing lead) is, therefore, effective for implementation of a lead reduction schedule.

NOT REPRODUCIBLE

1.4 STUDY OBJECTIVES

The objective of this study is to evaluate the effectiveness of various taxing methods as they relate to the lead reduction schedules of the Added Cost Study. Taxing methods are designed: 1) to minimize the price differential of the new grade versus the conventional regular grade, 2) to minimize the change in revenues generated through use of the tax, and 3) to minimize monitoring and control problems associated with the use of a taxing system. Several types of proposed tax systems are studied in relation to each of the selected lead-removal schedules:

- A per-gallon tax on fuel containing lead.
- A flat tax per pound of lead used in gasoline additives.
- Combinations of the above.

These three proposed tax systems do not exhaust all possible options. A graduated tax on gasoline, based on lead content, is an example of a different type of tax that could be used. Most options, however, are similar to the three used in this study insofar as the taxing systems are concerned but vary in basic design. An alternate design, for example, might specify that changes in total tax revenue generated be ignored--or that added revenue be used in tax credits or relief for various parties affected by lead reduction. Such revenues could be allotted to: 1) lead companies who will be phasing out lead additive manufacturing facilities, or 2) small refiners in the form of tax relief if it appears such refiners might be forced out of the gasoline manufacturing business.

1.5 STUDY PREMISES

The premises of this study on lead-related tax systems may be briefly stated as follows:

1) A tax can be imposed which will minimize the spread between the prices (at the pump) of leaded and unleaded gasolines.

2) Equalized prices at the pump will result in the forecasted demands used in the Added Cost Study. (See Table 1.)

3) The incremental values obtained from the added cost study, which reflect the cost of adding facilities, are suitable for tax analysis.

4) A tax can be levied such that refiners will have economic incentives for lead removal.

5) The analysis of the Added Cost Study forms the basis for the tax study data.

6) A three-grade distribution system is assumed.

7) Net revenue changes caused by lead-related taxation is to be minimized.

8) Final service station pump price differences for premium versus regular reflect a 3-cent spread over the incremental manufacturing cost.

9) Additional distribution costs for the third grade will be allocated to the new third grade only.

TABLE 1

NATIONAL DEMAND FORECAST FOR GASOLINE

Marketing Category	Billions of Gallons Per Year			
	93 Octane	94 Octane	100 Octane	Total
Three-Grade Subject Cases				
1971	6.2	55.8	29.8	91.8
1972	11.9	57.5	26.0	95.4
1973	17.4	59.2	22.4	99.0
1974	22.4	60.8	19.3	102.5
1975	35.3	55.6	16.2	107.1
1976	47.4	50.9	13.4	111.7
1977	58.9	46.6	10.6	116.1
1978	69.4	42.8	8.1	120.3
1979	78.9	39.2	5.9	124.0
1980	88.4	35.9	4.1	128.4
Two-Grade Reference Case				
1971		56.1	35.1	91.2
1972		58.0	36.2	94.2
1973		59.8	37.4	97.2
1974		61.7	38.5	100.2
1975		63.5	39.7	103.2
1976		65.3	40.8	106.1
1977		67.1	41.9	109.0
1978		68.9	43.1	112.0
1979		70.7	44.2	114.9
1980		72.4	45.2	117.6

1.6 EPA SCHEDULES STUDIED

Four schedules were selected from the Added Cost Study for this analysis on tax systems. These schedules, referenced from the Added Cost Study, are identified as A, O, N, and L. Projected lead levels for these four schedules are displayed in Table 2.

TABLE 2

SCHEDULED LEAD LEVELS AND PERCENT LEAD REDUCTION FROM 1971 BASE

SCHEDULES	YEARS								
	1972	1973	1974	1975	1976	1977	1978	1979	1980
Schedule A									
93, gm/gal	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94,gm/gal	2.2	2.3	2.5	2.6	2.7	2.7	2.7	2.8	2.8
100,gm/gal	2.5	2.7	2.8	3.0	3.0	3.0	3.0	3.0	3.0
% Lead Reduction	15	15	15	17	20	28	35	41	50
Schedule O									
93, gm/gal	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94,gm/gal	2.0	1.7	1.5	1.25	1.25	1.25	1.25	1.25	1.25
100,gm/gal	2.0	1.7	1.5	1.25	1.25	1.25	1.25	1.25	1.25
% Lead Reduction	21	33	45	56	63	68	71	74	77
Schedule N									
93,gm/gal	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94,gm/gal	1.0	1.0	0.75	0.5	0.5	0.5	0.5	0.5	0.5
100,gm/gal	1.0	1.0	0.75	0.5	0.5	0.5	0.5	0.5	0.5
% Lead Reduction	59	59	73	84	88	89	89	90	91
Schedule L									
93,gm/gal	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94,gm/gal	0.9	0.7	0.5	0.2	0.0	0.0	0.0	0.0	0.0
100,gm/gal	0.7	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0
% Lead Reduction	64	73	82	93	100	100	100	100	100

SECTION 2

CONCLUSIONS

2.1 GENERAL

Results from the study on tax show that no single tax method best achieves all study objectives for all schedules.

Schedule A can be met only through the use of a cents-per-gallon tax on gasoline. This method would increase taxes for the leaded grades and all grades equal to or greater than 94 octane (RON) while decreasing the tax on the new third grade. Any tax on lead would cause refiners to reduce lead content at a faster rate than envisioned in Schedule A.

For Schedules O, N, and L, objectives are most effectively met through a direct tax on lead additives. Lead is taxed and an excise tax credit of one-half cent/gallon is allowed on all unleaded gasoline below conventional regular* octane. Regulation on lead levels would be required if a gasoline tax is used to implement these schedules.

All tax systems should provide some means for keeping track of octane quality.

Small refiners will be hurt by both types of tax systems studied. However, the tax on lead will probably be less damaging than a tax on leaded gasoline that includes lead level regulation.

A tax on lead, even without regulation, will cause the desired reduction in U.S. tonnage of lead used in motor fuel for all schedules more severe than Schedule A. Lead

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*Approximately 94 RON.

levels in gasoline will vary, however, from refinery to refinery and from blend to blend within the same refinery.

The tax rates calculated for the next ten years are sensitive to gasoline sales and will require adjustments in later years to minimize changes in tax revenues due to deviations of actual demand from the study forecast.

Details on the results of imposing all three tax methods (tax on gasoline containing lead, direct tax on lead, and combinations of these) are reported in Section 4.

2.2 EFFECTS OF TAX ON GASOLINE CONTAINING LEAD

This type of tax minimizes the consumer price spread between conventional leaded gasolines and the low-lead or no-lead grade by adjusting the pump prices after the refiner's cost difference has been passed on to the retail outlet.

Since tax on gasoline is insensitive to lead levels it will tend to cause refiners to either lead gasoline at the most economical level (2 to 3 grams/gallon) or to avoid the tax entirely by producing conventional grades with no lead. For this reason, such a tax would be ineffective in implementing schedules O, N, and L unless it were accompanied by regulations on lead to satisfy the lead reduction patterns defined for the conventional grades. For example, the lead level for Schedule O *with regulated lead levels* (in 1975, this is 1.25 grams/gallon) can be achieved with a tax on leaded gasoline.

Schedule A, on the other hand, assumes that leaded grades are at economic lead levels. Therefore, the tax on gasoline containing lead would be effective in implementation of this schedule. *However, analysis shows that a tax would probably be necessary not only on the grades containing lead but also on any grade with a research octane above 93.* The reason for such octane qualification is that refiners with excess capacity might choose to remove lead from more than the third grade once a specific lead reduction schedule and tax rate is imposed. These refiners would probably choose to do so if their added cost of manufacturing the unleaded, higher-octane gasolines were less than the cost of lead plus the tax on these gasolines. These refiners would then have an economic advantage over those refiners with limited capacity who would be forced to pay the tax and buy the lead. Table 3 lists the tax rates for three of the years studied in Schedule A.

TABLE 3

SCHEDULE A TAX RATES

Year	Tax on Leaded Gasoline ¢/Gal	Tax Credit on Unleaded Gasoline ¢/Gal	Tax Spread Between Grades ¢/Gal
1974	1	1.5	2.5
1976	2	1.5	3.5
1980	2	2.0	4.0

The tax spreads required are 2.5 cents/gallon, 3.5 cents/gallon, and 4.0 cents/gallon for the years 1974, 1976 and 1980, respectively. These totals have been split between a tax increase on leaded gasoline and a tax decrease on unleaded gasoline in an attempt to balance the tax revenue generated. This tax schedule includes the effect of placing the added cost for distribution on the new third grade. The distribution cost was determined from the added distribution costs reported in the Added Cost Study with the assumption that the cost would be passed on to the consumer only in the new third grade.

The control of this tax will require monitoring the volumes of leaded and unleaded gasoline sales and also the octane rating of the unleaded grade.

2.3 EFFECTS OF DIRECT TAX ON LEAD

This type of tax, since it results in raising the cost of octane obtained with lead, provides an incentive to the refiner to reduce the amount of lead used and also tends to *equalize the manufacturing cost* of the leaded and unleaded regular grades. Since it does cause a reduction in lead usage this tax does not apply to Schedule A where the leaded grades were normally at refinery economic levels of up to 3.0 grams/gallon. However, for Schedules O, N, and L, this type of tax is effective. Tax rates are imposed so that the desired lead reduction program is approximated. Table 4 illustrates the tax rate for three of the years studied. These figures show that the more severe schedules will require the higher tax.

TABLE 4

DIRECT TAX ON LEAD ADDITIVES

FOR SCHEDULES O, N, AND L

Year	Schedule O	Schedule N	Schedule L
	Tax $/lb.	Tax $/lb.	Tax $/lb.
1974	1.85	2.50	5.00
1976	2.85	3.50	14.00
1980	3.40	4.20	14.00

Figure 2-1 is a simple illustration of the relationship of octane gain versus the amount of lead used. The curve shows that the octane gained by adding the first gram/gallon is higher than that for the second, etc. This explains why the tax must be escalated as the lead level of the motor fuel pool is decreased. Tax required for removing the last increment of lead (0-1 grams/gallon) is therefore greater than the tax required for removing previous increments (1-2 grams/gallon and 2-3 grams/gallon.)

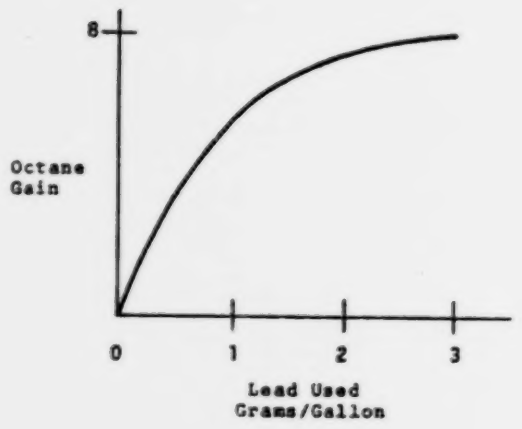

Figure 2-1. Octane Improvement versus Amount of Lead Used

Even without regulated lead levels, these tax rates would cause the refiners to reduce lead levels at the desired reduction rates. This does not mean that the actual lead levels in each grade will be at the same level but that the total lead consumed will decrease at a rate corresponding to the schedule. One of the major attributes of this type of tax is that it does not require regulation on the lead content of the leaded grades for Schedules O, N, and L.

This study assumes that distribution costs (averaging 0.72 cents/gallon) are allocated to the new third grade only. It is recommended that a tax credit of 0.5 cents/gallon be applied to the new grade. This offsetting credit will tend to minimize both the cost spread difference to the consumer and the total additional revenue generated.

The curves in Figure 2-2 permit the tax rate for any rate of lead removal to be determined for the years 1972, 1974, 1976, and 1980. This plot assumes the volume distributions used in the Added Cost Study and that the new third grade will be clear in 1974. For example, if a lead removal rate of 60 percent were desired in 1974, a tax rate of $2.15 per pound would be needed. The curve indicates that this tax must increase with time in order to maintain the 60 percent reduction in total lead usage. This requirement is due to increasing volumes of gasoline sales.

The implementation of a tax on lead basically requires monitoring lead sales from four major producers. The tax credit on the new third grade should not add a great deal of burden to the implied monitoring required if the unleaded gasoline is to be regulated clear in 1974.

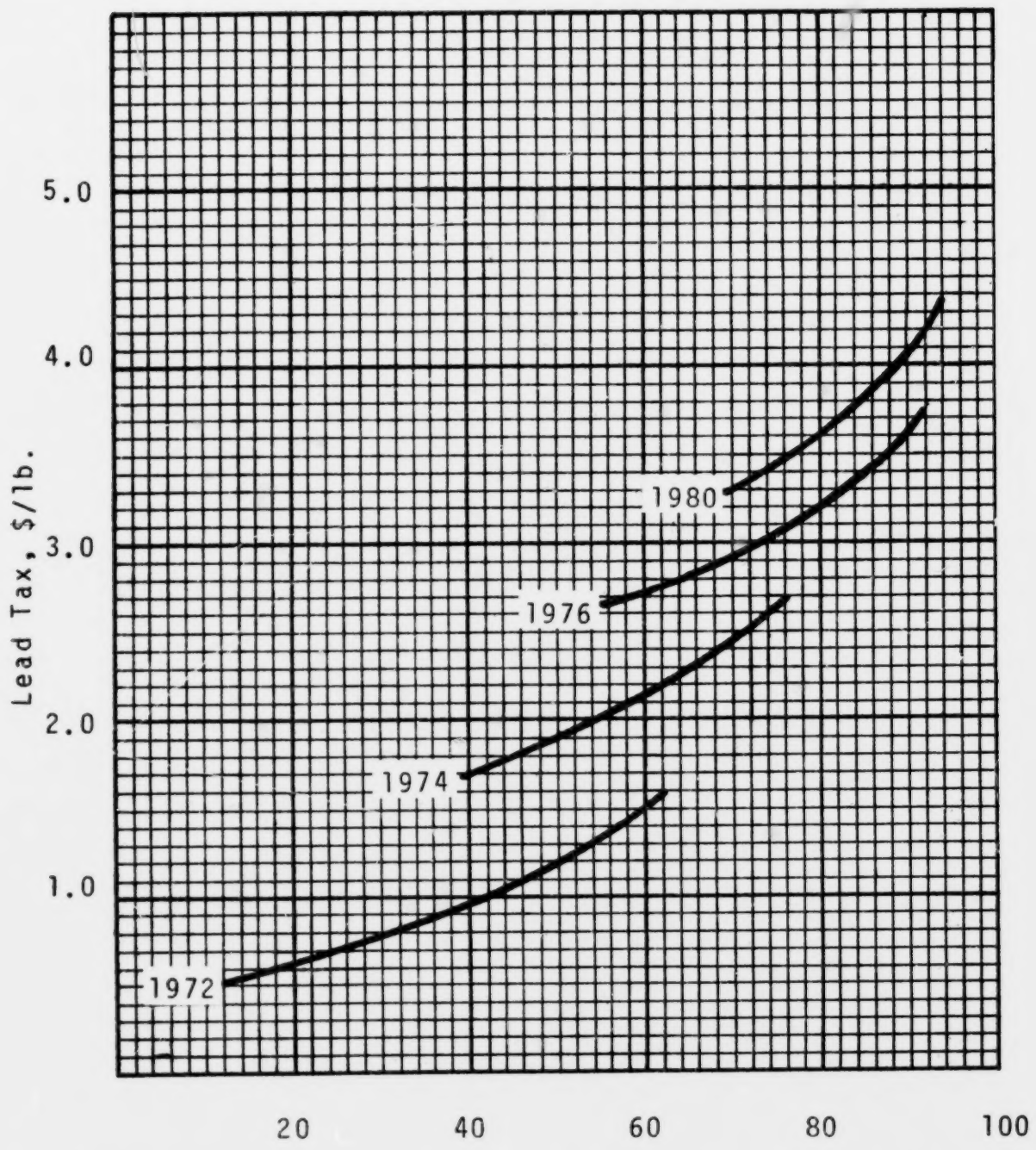

Figure 2-2. Percent Lead Reduction vs. Lead Tax

2.4 EFFECT ON CONSUMER

Any refiner's added cost (incurred to meet regulated restrictions on lead content and/or a tax to implement an even transition to a lead-reduction schedule) will probably be passed on to the final consumer of the products. The lead removal schedules studied are accompanied by a reduction in the average octane of the motor fuel. Therefore, the average per-gallon added cost to the consumer is not as large as that documented in past studies[3].

Lead-related taxes, by themselves, do not appreciably increase the total consumer outlay for gasoline since the taxes are balanced to minimize change in total gasoline tax revenue. The expected pump prices reflect the taxes, the added cost or credit for manufacturing the new grade of gasoline over the reference schedule, and an adjustment over all grades to retain the same profit, per gallon, on gasoline marketed. Details on this calculation are provided in Section 3. Table 5 summarizes the *relative expected prices* of the three grades of gasoline for the years 1974, 1976 and 1980 according to the taxes recommended for each schedule. Also shown are the assumed base figures for price of gasoline.

The added price of gasoline (over the base) ranges from one to two cents/gallon.

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[3]"U.S. Motor Gasoline Economics, Volume I", prepared by Bonner & Moore for the American Petroleum Institute in March, 1967.

TABLE 5

RELATIVE SERVICE STATION PUMP PRICES*

(¢/Gallon)

HYPOTHETICAL BASE PRICE

94 RON REGULAR 34.0
100 RON PREMIUM 38.0

	Schedule			
	A	O	N	L
1974				
94 RON Regular	35.4	35.2	35.1	35.5
Unleaded Regular - 93 RON	35.6	35.4	35.3	35.5
100 RON Premium	39.3	39.4	39.7	39.6
1976				
94 RON Regular	35.8	35.4	35.4	35.7
Unleaded Regular - 93 RON	35.8	35.6	35.6	35.6
100 RON Premium	39.9	39.9	40.2	40.4
1980				
94 RON Regular	35.0	35.7	35.6	36.0
Unleaded Regular - 93 RON	35.2	35.9	35.8	35.8
100 RON Premium	39.2	40.1	40.1	40.7

*Prices include selective taxing.

SECTION 3

STUDY METHODOLOGY

3.1 STUDY ASSUMPTIONS

3.1.1 Schedules Studied

The four schedules covered in this study were selected to represent the full spectrum of lead reduction rates analyzed in the Added Cost Study. Each represents a three-grade gasoline marketing system comprised of the two conventional grades and a new grade of gasoline. This new 93 RON grade of gasoline is "low-lead" (0.5 grams/gallon maximum) until 1974 when it is to be manufactured without lead. The schedules are described below, from the least severe to the most severe lead reduction in conventional grades.

1) *Schedule A*

Schedule A's conventional regular and premium gasolines are permitted to contain a maximum of 3 grams of lead additive per gallon through the scheduled years 1971-1980.

2) *Schedule 0*

Schedule 0 was designed to remove approximately 60 percent of the current lead additives by 1975 without inducing a business cycle in the construction industry. The two grades corresponding to current regular and premium gasolines are permitted to contain equal but diminishing lead levels through 1975 and are held constant at 1.25 grams/gallon thereafter.

3) *Schedule N*

Schedule N's two grades corresponding to current regular and premium gasolines are permitted to contain equal but diminishing lead levels through 1975. Their lead levels were reduced to 0.5 grams/gallon by 1975 without inducing a business cycle in the construction industry.

4) *Schedule L*

Schedule L removes lead from all grades as quickly as possible within the projected growth capacity of the construction industry. The 93 RON grade was required to be clear in 1974 and the other two grades become clear in 1976.

3.1.2 Incremental Manufacturing Costs

The various taxes for this study are derived from incremental manufacturing costs obtained from the Added Cost Study models of the petroleum refining industry.

The incremental cost of a given product is the cost of manufacturing an additional increment (gallon) of the product. This study's incremental costs include the cost of raw material, the cost of additional throughput through the processing units, and the cost of additives required in the product. If the manufacture of the product also yields additional by-products, a credit for these by-products is considered in calculating the incremental manufacturing costs. It should be noted that these incremental costs are not identical to those normally used in existing plants. This study's incremental costs more closely approximate average manufacturing costs because capital requirements for new facilities are included.

The incremental costs used in this study also change from year to year. This is caused by the changing octane requirements per barrel of raw material--a result of the changing ratios for the various grades of gasoline during scheduled years. Because of the changing cost differences from year to year, the tax rates must be calculated on an annual basis.

Incremental costs will also vary from refinery to refinery for many reasons. One refiner may manufacture a product at a lower incremental cost because he has newer and less costly processes and/or more economical raw material. Therefore, a tax will have a different effect on each refinery and each refinery will remove lead at somewhat different rates. These varying effects were studied using the modeling techniques described below.

3.1.3 Two-Sector Model

The Added Cost Study used linear programming models which represented the United States petroleum refining industry. These models studied various lead-reduction schedules to determine economic effects upon the overall industry. This modeling approach was used since the objective was to find the average added cost to meet the various schedules.

In order to determine the industry's response to various tax systems, it was determined that a linear programming model dividing the petroleum refining industry into two sectors would more accurately reflect this response. The primary refinery sectors considered were the "expanded (modernized) refinery" versus the "unexpanded refinery." The assumption was made that any single refinery in 1974, for

example, would most likely be either *unchanged* from 1971 (except for slight expansions and improvements brought about by modifying existing equipment) or *expanded* and ready for the "new gasolines" at projected 1976 to 1977 production levels. The selected modeling technique would then simulate responses of the two sectors to show any economic advantage that one sector might have over the other. This modeling technique also indicated the expected lead reduction rates for the different sectors. Therefore, a two-sector model was constructed to study the consequences of new taxes upon the unchanged versus expanded sectors of the petroleum refining industry.

3.2 PUMP PRICE CALCULATION

The following description on pump price calculation is meant only as a mechanism for estimating pump prices resulting from manufacturing cost differences. The prices determined in no way reflect refinery profitability but simply provide a method for arriving at relative pump prices that can be substantiated through historical data. This or any other method cannot be proven rigorously since pricing policies consider a wide variety of factors and many of them are not quantifiable.

3.2.1 Pump Price Spread Definition

The term *pump price spread* applies to the price differential between conventional regular and conventional premium gasoline and to the difference between conventional regular and the new grade of gasoline. This study assumes that pump prices could be estimated from incremental manufacturing costs. It further assumes that estimated pump prices can be used to evaluate the effectiveness of various taxing and regulatory alternatives, where "effectiveness" means the minimization of the price difference between leaded and unleaded regular.

3.2.2 Calculating Price Spreads

The development of pump price spreads is based upon interviews with four major oil companies (two are current marketers of a low-lead, third grade), observed market prices, reported gasoline prices[4] and the reference schedule results from the Added Cost Study. (The reference schedule assumed that lead would remain in gasoline consistent with today's

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[4]Oil & Gas Journal, July 19, 1971.

operations.) The reference schedule's *incremental manufacturing cost difference* between conventional premium and regular was 1 cent/gallon in each of the years studied. This compares to a *price spread at the pump* of 4 cents/gallon which has been exhibited over the past several years. However, these traditional differences are likely to change as the difference in incremental manufacturing cost changes from pressures such as regulated lead removal and/or the manufacture of low-lead or unleaded gasoline increases.

For this analysis it was assumed that the pump price spread between conventional regular and premium gasolines would continue to exhibit the difference in incremental manufacturing cost plus 3 cents/gallon. The pump price spread (PPS) was determined by the following method.

1) Determine the difference in incremental manufacturing cost of the new grade versus conventional regular (ΔR).

2) Determine the difference in incremental manufacturing cost of conventional premium versus conventional regular (ΔP).

3) Add 3 cents/gallon to the difference in incremental manufacturing costs of conventional premium versus conventional regular (item 2 above). This determines the PPS for premium.

4) Form the ratio between items one and two above, i.e., divide item 1 by item 2.

5) Multiply item 4 by item 3.

6) Add the average added cost of distribution to the new third grade (0.72 cents/gallon). This determines the PPS for the new grade of gasoline.

The equations describing these six steps are as follows:

For conventional premium, $PPS = \Delta P + 3$

For the new grade*, $PPS_{93} = (\Delta P+3)x\frac{\Delta R}{\Delta P} + 0.72$

Figure 3-1 illustrates this relationship. For example, when the conventional premium incremental manufacturing cost difference is at 1 cent/gallon, its pump price spread will be at 4 cents/gallon. This sets the ratio (slope) which defines the pump price as a function of the incremental manufacturing cost. In this example, the difference in incremental manufacturing cost for the new grade is 0.5 cents/gallon, and its corresponding pump price spread will be 2 cents/gallon before adding the distribution cost. As a formula statement:

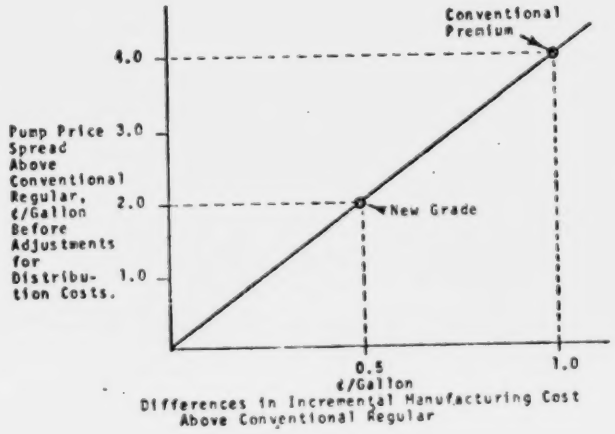

Figure 3-1. Incremental Manufacturing Cost Differences Versus Pump Price Spread

$$PPS_{93} = (1+3)x\frac{0.5}{1.0} + 0.72 = 2.72$$

The incremental manufacturing cost differences vary with pool octane requirements as described previously (see paragraph 3.1.2), with significant effect on the slope shown in

*Note: If $\Delta R<0$, then $PPS_{93} = \Delta R$.

NOT REPRODUCIBLE

Figure 3-1. In other words the differences in incremental manufacturing cost for premium above regular will not remain at 1.0 as shown in the figure.

Table 6 illustrates the incremental manufacturing cost above conventional regular for each of the schedules studied. The more severe schedules generally exhibit a higher difference in incremental manufacturing cost for the 100-octane grade. (Schedule L is an exception since lead levels in the two leaded grades are not equal as in Schedules O and N.) The difference in incremental manufacturing costs for all schedules increases throughout the schedule years. The annual increase results from the shift in the ratio of leaded premium and regular to the unleaded regular gasoline produced and by the reduction in *pool lead levels*. A consistent difference is shown for the reference schedule due to the constant ratio of leaded premium and regular.

The calculated pump price spreads developed through use of the methodology are displayed in Table 7 and will be referenced in Section 4 on study results.. Table 7 shows an increase each year for both grades in all schedules.

3.2.3 Calculating Price at the Pump

To estimate the final effect on the consumer, it was necessary to establish a pump price. This would then allow for an estimate of the consumer's added cost of purchasing gasoline under various lead removal schedules and tax systems used in their support.

For the tax on gasoline containing lead, the pump price spread mechanism described in paragraphs 3.2.1 and 3.2.2 was used with an assumed base price of 34 cents for regular. It should be noted that the 34 cents/gallon base price does not

TABLE 6

INCREMENTAL MANUFACTURING COST

ABOVE CONVENTIONAL REGULAR (94 RON)

(¢/Gallon)

Year	% in Total Pool			Schedule A		Schedule O		Schedule N		Schedule L		Reference
	93 RON	94 RON	100 RON†	93 RON	100 RON	93 RON	100 RON	93 RON	100 RON	93 RON	100 RON	100 RON††
1972	12	61	27	0.00	0.85	0.20	1.14	0.05	1.58			1.00
1973	18	59	23	0.06	0.84	0.16	1.17	0.02	1.19			1.00
1974	22	59	19	0.44	0.88	0.62	1.26	0.43	1.55	0.30	1.60	1.00
1975	33	52	15	0.43	1.03	0.67	1.45	0.34	1.67	0.00	1.60	1.00
1976	42	46	12	0.76	1.09	0.78	1.48	0.43	1.78	0.29	1.70	1.00
1980	69	28	3	1.03	1.24	0.93	1.44	0.46	1.48	0.29	1.70	1.00

†Reference scheduled premium to conventional regular ratio is 38/62 in each year.

††Reference schedule did not manufacture 93 RON grade.

TABLE 7

PUMP PRICE SPREAD ANALYSIS

93 AND 100 RON GRADES ABOVE LEADED 94 RON GRADE

(¢/Gallon)

Year	Schedule A			Schedule O			Schedule N			Schedule L*		
	93 RON		100 RON (Leaded)	93 RON		100 RON (Leaded)	93 RON		100 RON (Leaded)	93 RON		100 RON
	Without Distribution Cost	With Distribution Cost†		Without Distribution Cost	With Distribution Cost		Without Distribution Cost	With Distribution Cost		Without Distribution Cost	With Distribution Cost	
1972	0.00	0.72	3.85	0.73	1.45	4.14	0.14	0.86	4.58			
1973	0.27	0.99	3.84	0.57	1.29	4.17	0.07	0.79	4.19			
1974	1.94	2.66	3.88	2.10	2.82	4.26	1.26	1.98	4.55	0.86	1.58	4.60
1975	1.68	2.40	4.03	2.06	2.78	4.45	0.95	1.67	4.67	0.00	0.72	4.60
1976	2.85	3.57	4.09	2.36	3.08	4.48	1.15	1.87	4.78	(0.29)	0.43	4.71
1980	3.52	4.24	4.24	2.87	3.59	4.44	1.39	2.11	4.48	(0.29)	0.43	4.71

†Distribution costs = 0.72¢/gallon for each year.

*Comparison on Schedule L is versus Unleaded 94 RON Grade.

reflect any analysis to determine a base regular price; it is used only as a point of reference. Price spreads, as determined above, were then added to determine an initial price for the other two grades.

The pump price spread calculation includes a netback over the incremental manufacturing cost of the third grade. The adjusted netback was then added to the prices on all the grades in order to maintain a given profit per gallon of gasoline for both the refiners and the marketers.

Finally, taxes and distribution costs were added to the appropriate grades to arrive at the ultimate pump price. An example for the calculation of pump prices is shown below. The pump price calculated in the example is for 1976, Schedule A. Components in the calculation are:

- Hypothetical Base Price.....34 cents/gallon--
  conventional regular

- Pump Price Spread.....3.57 cents/gallon
  for 93 RON
  4.09 cents/gallon
  for 100 RON

- Overall Netback Correction...-0.24 cents/gallon

- Tax.....1.5 cents/gallon
  credit for unleaded
  2.0 cents/gallon
  debit for leaded.

The calculation is as follows:

	93 RON ¢/Gal	94 RON ¢/Gal	100 RON ¢/Gal
Hypothetical Base Price	34.0	34.0	34.0
PLUS Pump Spreads	37.57	34.0	38.09
MINUS Overall Netback Correction	37.33	33.76	37.85
PLUS Tax (Credits and Debits)	35.83	35.76	39.85

The *tax on lead* pump price calculation again assumes a hypothetical base price of 34 cents/gallon. The incremental spreads reported in Table 6 (page 3-9) were added to the third grade as well as the premium grade. The lead levels reported in the Added Cost Study were multiplied times the lead tax to calculate the added incremental cost of manufacture due to lead tax. These added costs were then added to the two leaded grades. An overall netback is then added to maintain equal profit for both refiners and marketers. Finally, the added distribution cost and tax credit were added to the third grade to give the ultimate pump prices for all three grades. An example is shown below for Schedule O, 1976.

Components in the calculation are:

- Hypothetical Base Price.....34 cents/gallon for conventional regular

- Incremental Manufacturing Costs Over Conventional Regular.....0.78 cents/gallon for 93 RON
  1.48 cents/gallon for premium

- Overall Netback Correction...0.64 cents/gallon

- Lead Tax Effect.....0.78 cents/gallon, calculated as follows:

  Tax = $2.85/lb, or 0.63 cents/gram

  therefore: Tax = 0.63 x 1.25 grams/gallon

  Tax = 0.78 cents/gallon.

- Tax Credit for Unleaded Gasoline.....0.5 cents/gallon

- Distribution cost on third grade.....0.72 cents/gallon

The calculation is as follows:

	93 RON ¢/Gal	94 RON ¢/Gal	100 RON ¢/Gal
Hypothetical Base Price	34.0	34.0	34.0
PLUS Incremental Manufacturing Cost	34.78	34.0	35.48
PLUS Added Cost of Lead Due to Tax	34.78	34.78	36.26

PLUS Added Spread at Pump (3 cents)	34.78	34.78	39.26
PLUS Overall Netback Correction	35.42	35.42	39.90
PLUS Distribution Cost	36.14	35.42	39.90
PLUS Tax Credit	35.64	35.42	35.42

3.3 TAX STRATEGIES

3.3.1 Tax on Gasoline Containing Lead

This type of taxing mechanism assumes that the difference in manufacturing costs between the two regular grades as previously discussed, will continue. This tax serves to offset the resulting price differential exhibited at the pump when these added manufacturing costs for the third grade are passed on to the customer.

3.3.2 Flat Tax Per Pound of Lead Used in Additives

An objective of the study was evaluation of a mechanism which would tax lead itself rather than the gasoline containing lead. It would be collected directly from the lead additive manufacturers and thus would require monitoring of lead sales from only four companies. This tax minimizes the differences in manufacturing cost for the two regular grades and thus assumes no price spread at the pump.

3.3.3 Calculated Revenue From Tax

The reference schedule forecasts are based on post-1971 car mileage being realized by motor vehicles through 1980. The three-grade schedules reflect the fuel demand anticipated for the car population comprised of the post-1971 motor vehicles which have the pollution abatement devices and lower-compression engines. Post-1971 autos are expected to have lower gasoline mileage than the pre-1971 vehicles. The forecasted demands for the three-grade schedules and the reference schedule are shown in Table 1 (page 1-9) of this report. Since the three-grade schedule does reflect post-1971 vehicle mileage, the yearly

demand figures for motor gasoline are shown to be higher than the reference schedule. The added revenue generated from this higher demand would be $2 billion by 1980 for a four-cent-per-gallon tax, independent of new tax strategies.

For each of the tax systems studied, taxing incentives and disincentives are evaluated such that the effect is to minimize added revenue generated. For *tax on leaded gasoline*, the added revenue is simply the sum of the appropriate tax times the volumes of 94 RON regular and 100 RON premium. The revenue is generally minimized through tax credits. These are the credits noted times the volume of the new 93 RON third grade.

For *tax on lead*, the added revenue is calculated by multiplying the sum of the volume of the conventional 94 RON regular and 100 RON premium times the expected lead level and correcting this to pounds (divide by 454 grams/pound) and then multiplying this times the tax. Again, revenue is generally minimized through a tax credit applied to the new grade.

3.3.4 Calculation of Average Distribution Costs

For this tax study, the added cost for distribution of the new third grade is applied only to that grade. Therefore, the distribution costs from the Added Cost Study were summed for the ten years, as indicated below, and divided through by the total volume of the third grade for those ten years to produce an average added cost for distribution (0.72 cents per gallon).

Year	Added Distribution Costs, MM$/yr.	Volume of New 3rd Grade, MM Gals.
1971	170	6.2
1972	255	11.9
1973	340	17.4
1974	340	22.4
1975	340	35.3
1976	340	47.4
1977	340	58.9
1978	340	69.4
1979	340	78.9
1980	340	88.4
TOTAL	3,145	436.2

$$\frac{3,145}{436.2} = 0.72 \text{ cents/gallon}$$

SECTION 4

STUDY RESULTS

4.1 TAX ON GASOLINE CONTAINING LEAD

This taxing mechanism is designed to minimize the spread between pump prices for leaded and pump prices for unleaded regular gasolines. It assumes that there are manufacturing cost differences between leaded and unleaded regular and that these differences will be passed on to the consumer. (See Pump Price Calculation, paragraph 3.2.) It should be emphasized that this tax does not discriminate between lead levels. For example, the tax on gasoline containing 0.5 grams/gallon would be the same as for gasoline containing 3.0 grams/gallon. Therefore, if lead is used at all, the refiner will tend to use the allowable maximum after 1973 if this tax goes into effect.

The implementation and control problems associated with this type of tax may be complex since it will be necessary to identify and monitor all gasolines containing lead. However, since each of the schedules analyzed in this study have the new grade unleaded after 1973, a control function is implied regardless of actions taken concerning the tax issue.

4.1.1 Schedule A Results

Schedule A is for a three-grade marketer in which the lowest octane grade (93.RON) is permitted to have 0.5 grams/gal of lead additive until 1974, at which time all lead is removed from it. The grades corresponding to current regular and premium gasolines are permitted to contain a maximum of 3 grams/gallon of lead through the scheduled years.

The tax rates for Schedule A are shown on Table 8. The tax required to minimize the pump price spread is listed in the column *Tax, ¢/Gallon*. The Revenue Generated figures reflect the resulting change in revenue on yearly and cumulative bases. The combination tax is an attempt to balance the revenue by offsetting a tax on leaded gasoline with a tax credit on unleaded gasoline.

The sensitivity analysis data presented in Table 8 are the results obtained by varying the percentage of the new grade in the total motor fuel pool. This analysis was performed to evaluate revenue fluctuations caused by deviations from the original demand forecasts. This sensitivity analysis indicates that the balance on the revenue generated can be affected severely by a plus or minus 10 percent demand on the unleaded regular grade. This is due primarily to the 2 cents/gallon credit applied to the new grade to keep the revenue receipts in balance. If the demand for the unleaded grade exceeds the forecast, it may be necessary to remove or reduce the tax credit. If this occurs in the late 1970's, those cars using the third grade will be mostly newer cars which may not be able to switch back to the cheaper leaded grade, and therefore the desired lead removal probably would still be accomplished.

If Schedule A's lead reduction rates are to be realized, *it will be necessary to identify the octanes of gasoline to which the tax applies*. For example, implementation of the tax schedules as shown in Table 8 without this further identification would cause many refiners to remove lead from their conventional regular grade and possibly not produce a third grade. This would result in a credit on tax for their conventional regular and a saving on the investment required to distribute three grades of gasoline. This would cause a much more severe lead reduction rate than Schedule A intends to provide.

TABLE 8

SCHEDULE A - TAX ON GASOLINE CONTAINING LEAD

(¢/Gallon)

Year	Pump Price Spread[1]	Tax, ¢/Gallon	Revenue Generated ($ Billions)		Combination[2] Tax, ¢/Gallon		Revenue Generated[2] ($ Billions)		Cumulative Revenue[3] Sensitivity Analysis ($ Billions)	
			Year	Cum.	Unleaded	Leaded	Year	Cum.	+10%	-10%
1972	0.7									
1973	1.0									
1974	2.7	2.5	2.0	2.0	-1.5	1.0	0.5	0.5	0.4	0.5
1975	2.4	3.5	2.5	4.5	-1.5	2.0	0.9	1.4	1.2	1.6
1976	3.6	3.5	2.3	6.8	-1.5	2.0	0.6	2.0	1.6	2.3
1977		3.5	2.0	8.8	-1.5	2.0	0.3	2.3	1.7	2.8
1978		4.0	2.0	10.8	-2.0	2.0	-0.4	1.9	1.0	2.7
1979		4.0	1.8	12.6	-2.0	2.0	-0.7	1.2	0.0	2.3
1980	4.2	4.0	1.6	14.2	-2.0	2.0	-1.0	0.2	-1.3	1.7

[1]See Table 7.

[2]An increase in tax on leaded gasoline with an offsetting reduction in tax on unleaded gasoline to balance revenue generated.

[3]The volume of the third grade was increased and decreased by 10 percent and cumulative revenue was calculated using the combination tax.

Some arguments against removing lead from some of the conventional regular at today's octane level rather than producing a third grade are:

1) The investment required in the early years is greater than that required by most three-grade schedules, possibly causing cyclical conditions in the engineering and construction industries independent of government regulations.

2) The owners of pre-1971 cars, which require leaded gasoline, are forced to purchase the premium grade at a price approximately 4 to 5 cents per gallon higher than the price of leaded regular. This amounts to 40 to 50 dollars per year for the average consumer.

3) Removal of lead from conventional regular may also require the 1971-1974 cars to purchase the premium grade if the additives used in the unleaded grade through 1974 are removed to prevent fouling of the emission abatement devices required for the post-1975 cars.

4) The combination tax designed to minimize revenue changes would actually cause significant revenue losses.

Modifying the regulations to tax gasoline containing lead and *all gasolines with a research octane number equal to that of conventional regular or greater* would not only minimize the pump price spread between leaded and unleaded

regular, but would also provide incentives for manufacturing the unleaded gasoline as a third grade. This modification also has certain disadvantages, such as:

1) Discouraging the rapid reduction and removal of lead,

2) Penalizing the marketers of unleaded gasoline of high octane,

3) Tending to force the marketing of three grades of gasoline at all service stations.

Added cases were completed for the EPA to study the added cost of manufacturing the new 93 RON grade with 0.5 grams/gallon of lead through 1980. This would be permissible if the motor vehicle pollution abatement devices could function with an acceptable life on cars using motor gasoline with this lead content. If the new grade were allowed to contain this quantity of lead in the latter years, the added cost of manufacturing this grade over the conventional regular, at 2 to 3 grams/gallon, would be negligible. Therefore, no tax should be needed to act as an incentive for equalizing the pump prices of the two grades. The third grade likely would not be needed.

4.1.2 Schedule O and N Results

Lead removal Schedule O permits the new third grade to use 0.5 grams/gallon until 1974, at which time all lead is removed from the new grade. The two grades corresponding to current regular and premium gasolines are permitted to contain equal, but declining lead levels throughout the schedule.

Schedule O was designed to remove approximately 60% of the current lead additives without inducing a business cycle in the construction industry.

Schedule N permits use of 0.5 grams/gallon in the new grade until 1974, at which time all lead is removed from the new grade. The two grades corresponding to current regular and premium gasolines are permitted to contain equal, but declining, lead levels throughout the schedule. These traditional grades are reduced to 0.5 grams of lead per gallon at the earliest date (by 1975) without inducing a business cycle in the construction industry.

The tax rates for Schedules O and N are shown on Table 9. The tax required to minimize the pump price spread is noted in the columns *Tax Spread, Cents Per Gallon* for each schedule. The revenue generated figures reflect the change in the revenue on yearly and cumulative bases for the projected taxes. In order to utilize the tax on leaded gasoline and have the industry react in accordance with the schedules noted, it will be necessary to *regulate* the maximum amount of lead in each grade of leaded gasoline. These maximum lead levels for each of the schedules are noted in Table 10.

A *graduated tax* on leaded gasoline, e.g., the rate as a function of lead content, could be determined for Schedules O and N and thus remove the need for the maximum lead restriction. However, the *same results can be achieved* by placing a tax on lead and thus reducing the monitoring problems inherent in trying to measure the amount of lead in each gallon of gasoline sold. It should be noted that even with these maximum lead regulations, the tax on leaded gasoline *would still be required* in order to maintain the minimum pump price spread between the new grade and conventional regular.

TABLE 9

SCHEDULE O AND N - TAX ON GASOLINE CONTAINING LEAD

Year	Schedule O					Schedule N				
	Tax Spread ¢/Gal	Combination Tax[1]		Revenue Generated[1] $/Billions		Tax Spread ¢/Gal	Combination Tax[1]		Revenue Generated[1] $/Billions	
		Unleaded ¢/Gal	Leaded ¢/Gal	Year	Cum.		Unleaded ¢/Gal	Leaded ¢/Gal	Year	Cum.
1974	3.0	-1.0	2.0	1.4	1.4	2.0	-1.0	1.0	0.6	0.6
1975	3.0	-1.0	2.0	1.1	2.5	2.0	-1.0	1.0	0.4	1.0
1976	3.0	-1.5	1.5	0.2	2.7	2.0	-1.0	1.0	0.1	1.1
1977	3.0	-1.5	1.5	0.0	2.7	2.0	-1.0	1.0	0.0	1.1
1978	3.5	-2.0	1.5	-0.6	2.1	2.0	-1.0	1.0	-0.2	0.9
1979	3.5	-2.0	1.5	-0.9	1.2	2.0	-1.0	1.0	-0.3	0.6
1980	3.5	-2.0	1.5	-1.2	0.0	2.0	-1.0	1.0	-0.5	0.1

[1]An increase in tax on leaded gasoline with an offsetting reduction in tax on unleaded gasoline to balance revenue generated.

TABLE 10

MAXIMUM LEAD LEVEL REGULATION REQUIRED

FOR ALL LEADED GASOLINE

(Grams/Gallon)

Year	Schedule O	Schedule N
1972	2.00	1.00
1973	1.70	1.00
1974	1.50	0.75
1975	1.25	0.50
1976	1.25	0.50
1977	1.25	0.50
1978	1.25	0.50
1979	1.25	0.50
1980	1.25	0.50

4.1.3 Schedule L Results

Schedule L is a lead removal schedule for a three-grade marketer. It removes lead from all grades as quickly as possible within the projected growth capacity of the construction industry. The 93 RON grade was required to be clear in 1974 and all grades were clear in 1976, causing a business cycle in the construction industry.

Schedule L has the most severe feasible lead reduction rate of the three-grade schedules. This severity can be accomplished only through regulation or high taxes on lead additives. It was found that the severity of the lead removal tended to equalize the manufacturing cost of the leaded and unleaded regular gasolines in the years 1974 and 1975. This

is caused by the clear octane of the leaded 94 approaching the octane of the new grade (as illustrated in Table 11). The result is a small saving in manufacturing cost which is partially offset by the added cost of lead used to raise the octane to 94. The years following 1975 have no leaded gasoline and therefore a tax is not applicable.

TABLE 11

SCHEDULE L, LEAD LEVELS AND OCTANE RATINGS

	1972	1974	1976	1980
93 Octane Grade				
TEL gm/gal	0.4	0.0	0.0	0.0
Leaded RON	93.0	-	-	-
Clear RON	90.4	93.0	93.0	93.0
94 Octane Grade				
TEL gm/gal	0.9	0.5	0.0	0.0
Leaded RON	94.0	94.0	-	-
Clear RON	89.2	91.0	94.0	94.0
100 Octane Grade				
Tel gm/gal	0.7	0.3	0.0	0.0
Leaded RON	100.0	100.0	-	-
Clear RON	98.4	99.2	101.4	100.7

4.2 TAX ON LEAD

As mentioned earlier, a tax on lead to a refiner means lead is more expensive. Refiners add lead to gasoline until the cost of octane gain from lead balances with costs of octane gain from manufacture. The greatest octane gain comes from the first portion of the lead and octane gain per unit of lead declines with increasing lead use. In other words, there is a greater octane gain from the first gram than from the second. Therefore, if lead becomes more expensive, a refiner will find the octane level previously achieved through lead addition can be achieved more economically through manufacture (via increasing reformer severity, etc.).

4.2.1 Schedule A Results

A tax on lead will stimulate the industry to remove lead faster than was defined for Schedule A. The reason is that the two leaded grades are at optimal lead usage per gallon of motor gasoline for the years studied and any lead tax will tend to reduce this level. Optimal is defined as that level where the refiners' manufacturing cost is less than the cost of lead for additional octane. The reduction of lead is achieved in this schedule because of the increased demand for the new grade from 1971 through 1980.

4.2.2 Schedules O, N and L Results

Schedules O, N and L can be implemented effectively with a tax on lead. As schedules increase in severity, more severe lead taxes are required. Further, all schedules show an increasing tax through time because of the required reduction of lead through time. Table 12 summarizes the lead tax, in dollars per pound of lead contained in lead additive, for each

TABLE 12

SCHEDULES O, N AND L TAX ON LEAD

(Dollars Per Pound)

Year	Schedule O				Schedule N				Schedule L			
	Pool Lead Level	Tax $/lb.	Revenue ($ Billions)		Pool Lead Level	Tax $/lb.	Revenue ($ Billions)		Pool Lead Level	Tax $/lb.	Revenue ($ Billions)	
			Annual	Cum.			Annual	Cum.			Annual	Cum.
1972	1.81	0.65	0.3	0.3	0.94	1.45	0.3	0.3	0.8	1.80	0.3	0.3
1973	1.49	0.75	0.24	0.5	0.91	1.45	0.3	0.6	0.6	3.60	0.5	0.8
1974	1.17	1.85	0.5	1.0	0.59	2.50	0.3	0.9	0.4	5.00	0.5	1.3
1975	0.84	2.45	0.5	1.5	0.34	3.10	0.3	1.2	0.1	10.50	0.2	1.5
1976	0.72	2.85	0.5	2.0	0.29	3.50	0.3	1.5	0.0	14.00	0.0	1.5
1977	0.61	3.00	0.5	2.5	0.25	3.70	0.2	1.7	0.0	14.00	0.0	1.5
1978	0.53	3.15	0.4	2.9	0.21	3.90	0.2	1.9	0.0	14.00	0.0	1.5
1979	0.45	3.30	0.4	3.3	0.18	4.10	0.2	2.1	0.0	14.00	0.0	1.5
1980	0.39	3.40	0.4	3.7	0.15	4.20	0.2	2.3	0.0	14.00	0.0	1.5

of three schedules. The table also shows the revenue generated per year and the cumulative tax on lead. The expected lead levels on the total United States gasoline pool for each schedule is shown for comparative purposes.

The tax on lead figures shown in Table 12 do not consider the added cost of distribution for the new third grade of gasoline. Therefore, there might still be a pump price spread which accounts for this added distribution cost. Table 13 shows a 0.5 cents/gallon tax credit on the third grade of gasoline to offset the 0.72 cents/gallon distribution cost for this grade. This credit should only apply for unleaded gasoline below conventional regular to accomplish the desired objective. This credit will also minimize the revenue generated from the lead tax. The reasons for using an excise tax credit rather than changing the lead tax are:

1) The lead reduction rates are closely tuned to the tax on lead and altering the tax would alter the reduction rates significantly, and

2) Changing the lead taxes would not help to balance tax revenue.

Table 14 illustrates the changes in tax revenue receipts that occur when the volume of the third grade is decreased or increased by 10 percent. For Schedule O this analysis implies that the 93 grade volume could increase by about 35 percent before the cumulative revenue results become negative. For Schedule N, since the base number is quite close to zero, the increase of 10 percent results in a negative cumulative revenue by 1980. Since the tax revenue is received only through 1975 for Schedule L (all grades are clear after 1975 in this schedule, and the lead levels of the other two grades are less than 0.5 grams/gallon), revenue is insensitive to variances in the volume of the third grade sold.

TABLE 13

TAX ON LEAD DOLLARS PER POUND + 0.5¢/GALLON

TAX CREDIT FOR UNLEADED GASOLINE*

Year	Schedule O				Schedule N				Schedule L			
	Pool Lead Level	Tax $/lb.	Revenue ($ Billions)		Pool Lead Level	Tax $/lb.	Revenue ($ Billions)		Pool Lead Level	Tax $/lb.	Revenue ($ Billions)	
			Annual	Cum.			Annual	Cum.			Annual	Cum.
1972	1.81	0.65	0.3	0.3	0.94	1.45	0.3	0.3	0.8	1.80	0.3	0.3
1973	1.49	0.75	0.2	0.5	0.91	1.45	0.3	0.6	0.6	3.60	0.5	0.8
1974	1.17	1.85	0.4	0.9	0.59	2.50	0.2	0.8	0.4	5.00	0.3	1.1
1975	0.84	2.45	0.3	1.2	0.34	3.10	0.1	0.9	0.1	10.50	0.0	1.1
1976	0.72	2.85	0.3	1.5	0.29	3.50	0.0	0.9	0.0	14.00	**	1.1
1977	0.61	3.00	0.2	1.7	0.25	3.70	-0.1	0.8	0.0	14.00		1.1
1978	0.53	3.15	0.1	1.8	0.21	3.90	-0.1	0.7	0.0	14.00		1.1
1979	0.45	3.30	0.0	1.8	0.18	4.10	-0.2	0.5	0.0	14.00		1.1
1980	0.39	3.40	-0.1	1.7	0.15	4.20	-0.3	0.2	0.0	14.00		1.1

*0.5 cents/gallon credit applies for clear grades below conventional regular after 1973.

**Assumed tax credit dropped and no revenue generated from 1976 and after because all grades are lead-free.

TABLE 14

REVENUE SENSITIVITY ANALYSIS (CUMULATIVE)

TAX ON LEAD

(Including 0.5¢/Gal Credit on Unleaded Gasoline)

($ Billions/Year)

Year	Schedule O			Schedule N			Schedule L		
	-10%*	Base	+10%**	-10%*	Base	10%**	-10%*	Base	+10%**
1972	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
1973	0.5	0.5	0.5	0.6	0.6	0.6	0.8	0.8	0.8
1974	0.9	0.9	0.9	0.8	0.8	0.8	1.1	1.1	1.1
1975	1.2	1.2	1.1	0.9	0.9	0.8	1.2	1.1	1.1
1976	1.6	1.5	1.3	1.0	0.9	0.8	0.0	0.0	0.0
1977	1.8	1.7	1.4	1.0	0.8	0.7	0.0	0.0	0.0
1978	2.0	1.8	1.4	0.9	0.7	0.5	0.0	0.0	0.0
1979	2.1	1.8	1.3	0.8	0.5	0.2	0.0	0.0	0.0
1980	2.2	1.7	1.2	0.6	0.2	-0.1	0.0	0.0	0.0

*Reduced the 93 RON grade volume by 10% and added this volume to the 94 RON grade.

**Increased the 93 RON grade volume by 10% and reduced the 94 grade volume by the volume added to the 93 grade.

Based on the sensitivity analysis in the Added Cost Study when going from 93 RON to 91 RON for the third grade, the *pump price spread* sensitivity is approximately 0.25 cents/RON. If the resulting third grade is 91 RON versus the 93 RON reported, and the tax rates proposed are adopted, the results would be an added incentive of 0.5 cents/gallon to the consumer to purchase the third grade.

4.3 TAX VERIFICATION - TWO-SECTOR MODEL

The added cost study used linear programming models which represented the United States petroleum refining industry as one average 100MB/D refinery. These models studied the economic effects of each schedule on the overall industry. This modeling approach was used since the objective was to find the average added cost to meet the various schedules.

In order to determine the industry's varying response to tax systems, it was determined that a linear programming model dividing the petroleum refining industry into two sectors would better reflect these responses. The refinery sectors considered were the "expanded (modernized) refinery" versus the "unexpanded refinery." The assumption was made that any single refinery in 1974, for example, would likely be either *unchanged* from 1971 (except for slight expansions and improvements brought about by modifying existing equipment) or *expanded* and ready for the "new gasolines" at 1976 to 1977 production levels. This technique would then simulate responses from the two sectors (or an indication on large versus small refiners) and show any economic advantage that one sector might have over the other. This modeling technique also indicates the expected lead reduction rates for the different sectors.

The two-sector model was used on Schedules A and N to test the effect of various taxes in 1974. Table 15 is a brief verification summary comparing the individual sector results from the two-sector model versus the results obtained in the Added Cost Study. The results show a good verification. A slight difference results because the sum of the unit sizes,

TABLE 15

SUMMARY OF MODEL VERIFICATION RUNS

1974

	Schedule	Added Cost Study "One Sector" Results	Combined "Two Sector" Results	Expanded Sector	Unexpanded Sector
Pool Lead Level, gm/gal	A	1.80	1.61	1.56	1.66
	N	0.59	0.59	0.59	0.59
Incremental Manufacturing Cost					
93 Octane Clear versus 94 Octane, ¢/gal	A	0.44	0.34	0.29	0.40
	N	0.43	0.38	0.19	0.64
100 Octane versus 94 Octane, ¢/gal	A	0.88	0.83	0.77	0.90
	N	1.55	1.43	1.19	1.79
U.S. Crude Demands, MMBbl/yr	A	5044	5020	2782	2238
	N	5025	5054	3299	1755
Aromatic Content of the Motor Gasoline Pool, %	A	23	21	20	22
	N	28	29	31	25
Refining Revenue versus Crude, $/Bbl	A	0.62	0.61	0.64*	0.58
	N	0.56	0.55	0.49*	0.67

*Includes the cost effect of facilities added from 1971 to 1974.

etc., as defined for tne two sectors, is not exactly equal to the sum determined for the specific year studied in the Added Cost Study.

Refinery revenue per barrel of crude has been added to show the order of magnitude of profit within the industry sectors. This revenue accounts for the receipts in sales, cost of raw materials, costs of operation and labor and the cost of capital for new facilities.

4.3.1 Two Sector Results, Tax On Gasoline Containing Lead

An objective of the tax on leaded gasoline is the minimization of the pump price differential for unleaded and leaded lower octane fuels so the motorist will not have an economic incentive for one grade over the other. The refiner will consider the *actual tax rate* (cents/gallon) and if he can manufacture the same conventional grade(s) of gasoline without lead at a lower cost than the tax rate allows, he will do so. In other words, the tax will raise the retail price of leaded gasoline and if a segment of the industry can profitably manufacture unleaded fuel of comparable quality it will market this fuel in competition with the more expensive (taxed) leaded fuel. The premise is therefore made that, given a tax on a gasoline *without RON restriction*, a portion of the refining industry will be able to manufacture an economical, unleaded gasoline of a quality to compete with the taxed, leaded gasoline.

Based on this premise, the model was set to allow for the manufacture of some unleaded 94 octane motor fuel. It was also assumed that if a refiner could manufacture unleaded 94 octane motor fuel profitably, he might then upgrade the lead-free 93 octane grade and save the investment costs for distribution of the third grade. Therefore, the model was constructed to reflect the savings that would be realized in marketing only two grades of motor gasoline.

In using this two-sector model, results from a reference schedule were compared to proposed tax method results. The configuration of the unchanged sector was always the same as shown in the reference schedule for 1971 in the Added Cost Study. The expanded sector was the 1976 configuration from a given schedule. The total production of the two sectors had to meet the product demands for 1974, which was used as the intermediate year. Allocation of added plant capacities for the expanded sector was a function of the amount of plant investment required by 1976. Therefore, the expanded sector represented the capacities of the various processes needed by 1976, multiplied by the ratio of investment in 1974 over the investment required by 1976. An example of the expanded sector's investment ratio calculation is shown below.

$$E = \frac{I_{74}}{I_{76}}$$

where:

I_{76} = Industry investment to meet a given schedule by 1976.

I_{74} = Industry investment to 1974.

E = Fraction of total industry expanded to meet 1976 conditions.

The individual unit capacities for the expanded sector were estimated from the following relation:

$$C_E = C_{76} \times E$$

$$Cu = C_{71} (1-E)$$

where:

C_{76} = Industry model unit capacity for 1976 for the subject schedule.

C_{71} = Industry model unit capacity for 1971 for the reference schedule.

C_E = Unit capacity for expanded sector.

Cu = Unit capacity for unchanged sector.

The transfer of only finished products between sectors was represented with a transfer variable having a cost penalty equal to 5 percent of the product value. Original allocation of product demands for the sectors was determined using ratios of crude capacities for the two sectors.

Both sectors allowed a minimal amount of process expansion on the noncritical type units to compensate for any nonlinearities in product demands.

Table 16 summarizes the results of a tax on leaded gasoline of two cents per gallon without adding the stipulation that this tax be applied to all gasolines equal to or above 94 octane. This tax on leaded gasoline, without the added stipulation, gave quite different results than might be expected.

TABLE 16

SUMMARY OF TAX ON LEADED GASOLINE - 1974

(Tax = 2 Cents Per Gallon)

Category	Added Cost Study "One Sector" Results		Combined "Two Sector" Results	Expanded Sector	Unexpanded Sector
	Schedule A	Schedule N			
Motor Gasoline Volumes, Billions Gallons/Year					
Unleaded 93 Octane	22.4	22.4	8.6	1.9	6.7
Unleaded 94 Octane	0.0	0.0	53.1	39.7	13.4
Leaded 94 Octane	60.8	60.8	21.5	4.8	16.7
Total 94 Octane	60.8	60.8	74.6	44.5	30.1
Leaded 100 Octane	19.3	19.3	19.3	10.6	8.7
Total Motor Gasoline	102.5	102.5	102.5	57.0	45.5
Percent Unleaded Gasoline	22	22	60	73	44
Total Lead Usage, 10^3 Tons/Year	227	66	135	-	-
Estimated Average Pump Price, Cents/Gallon*					
93 Octane Regular	35.2	35.3	38.3	-	-
94 Octane Regular	35.1	35.1	34.8	-	-
100 Octane Premium	38.9	39.5	39.6	-	-
U.S. Crude Demands, MMBbl/Year	5044	5025	5065	2914	2151
Aromatic Content of Motor Gasoline Pool, %	23	28	31	34	26
Refining Revenue Versus Crude, $/Bbl**	0.62	0.56	0.79	0.78	0.82

*Includes 2 cent/gallon tax on leaded gasoline.
**Includes credits for tax and distribution costs.

This study was set up to simulate Schedule A with the model allowed to shift to Schedule N's lower lead level through added process construction if it were profitable. On the surface this would appear to be an undesirable move as Schedule A's revenue per barrel of crude run was significantly higher than Schedule N's. A tax of two cents per gallon was imposed, which is one-half cent less than the reported spread for A (including cost of distribution). If this 2-cent tax causes the refiner to shift to lead reduction rates comparable to N, a higher tax would increase the shift. The figures show a shift in unleaded 94 RON regular and a shift from three-grade marketing to two-grade marketing. These shifts are limited by the engineering and construction industry capacity. Industry would probably not go to quite this high a shift because of capital shortage and because many companies in the industry have already committed to market a third grade of gasoline. Results also indicate that those companies that have stayed with the two-grade system can most probably continue along this course with proper additions to their refining capacity. Stipulation that the tax be applied to *all gasoline above a certain octane rating* will eliminate this phenomenon.

The results indicate that if such a tax were imposed on the industry that expansion would probably exceed Schedule N's level, causing a cycle in the engineering and construction industry because of the economic incentive to the refiner to remove lead from the conventional regular grade. This would cause the average aromatic content to go above the levels described in Schedules A and N. Also, the results indicate that the desired minimizing of price spread between leaded and unleaded regular at the pump might not be achieved with the 2-cent tax unless the added tax on gasoline equal to or greater than conventional regular is stipulated.

4.3.2 Two Sector Results, Tax on Lead

1) *Schedule A*

A nominal lead tax of $0.50/pound was run on the model to show how this would reduce lead usage when the model was essentially locked into Schedule A's configuration and unit sizes. A small amount of unit expansion was allowed on all processes except very critical processes such as cat reforming, hydrocracking, and catalytic cracking. Table 17 summarizes the results of the lead tax. The tax in the two sector model reduced the average lead level from 1.61 grams/gallon in the verification run to 1.36 grams/gallon or a 15 percent reduction in lead usage. This reduction was achieved by operating at higher and more costly severity levels.

2) *Schedule N*

Schedule N shows that tax on lead alone, as opposed to regulated lead levels, can achieve a desirable reduction in total lead usage. This allows the smaller refiner and the "unexpanded" refiner to marginally go above the desired lead levels until they can expand or take other steps to lower their total lead usage. The larger refiners, on the other hand, can market a lower leaded gasoline through more economical manufacturing options. In reviewing the results of the two sector model, it was found that when lead levels are sought without regulation, the unexpanded sector (and probably small refiners) had a tendency to require more lead in premium gasoline.

TABLE 17

SUMMARY OF TAX ON LEAD[†]

1974

	Schedule	Combined Verification "Two Sector" Results	Combined Tax "Two Sector" Results	Expanded Sector	Unexpanded Sector
Pool Lead Level, gm/gal	A	1.61	1.36	1.39	1.34
	N	0.59	0.63	0.51	0.83
Incremental Manufacturing Cost 93 Octane Clear versus 94 Octane, ¢/gal	A	0.34	0.42	0.33	0.53
	N	0.38	(0.12)	(0.22)	0.06
100 Octane versus 94 Octane, ¢/gal	A	0.83	1.23	1.15	1.36
	N	1.43	1.08	0.93	1.37
U.S. Crude Demands, MMBbl/yr	A	5020	5031	2872	2159
	N	5054	5019	3264	1755
Aromatic Content of the Motor Gasoline Pool, %	A	21	21	21	21
	N	29	28	31	24
Refining Revenue versus Crude, $/Bbl	A	0.61	0.61	0.65	0.52
	N	0.55	0.55	0.50	0.65

[†]Lead tax imposed per pound: Schedule A - $0.50; Schedule N - $2.25.

Table 18 summarizes the lead levels of the various grades for Schedule N when taxed in the two sector model. The pool lead level of 0.63 grams/gallon compares favorably to the 0.59 grams/gallon desired for Schedule N. The similarity of Schedule A's sector lead levels results from the near-equal size of the two sectors.

TABLE 18

AVERAGE LEAD LEVEL OF MOTOR GASOLINE

Schedule N - 1974 - Lead Tax = $2.50/lb.

(Grams/Gallon)

Sector	94 Octane	100 Octane	Pool
Expanded	0.86	0.21	0.51
Unexpanded	0.91	1.07	0.83
Pool			0.63

4.4 SMALL REFINERS

The added cost study showed that the small refiner experiences a higher cost to maintain a given lead reduction schedule than the large refiners.

The tax rates reported should achieve the objective of bringing about the desired lead reduction rates for all but the smallest of refineries. The smaller the refinery, the greater is the incentive required to remove lead. This is due to the less flexible capabilities and the smaller economies of scale for adding facilities. As shown in Figure 4-1, the taxes do cause the smaller refiners to reduce their lead usage, although at a slower rate. It would be physically impossible to generate a tax that affects all refiners in the same way and therefore cause a uniform lead reduction rate. Today, the smaller refiner tends to use more lead, on the average, than the large refiner because of his limited facilities. Analysis shows this phenomenon will continue if a tax on lead is imposed. The tax on lead (without regulated lead levels) does, however, allow the small refiner to continue lead use and produce salable gasoline. On the other hand the tax on gasoline and accompanying regulation of lead content could endanger the small refiner's ability to manufacture and market motor fuel.

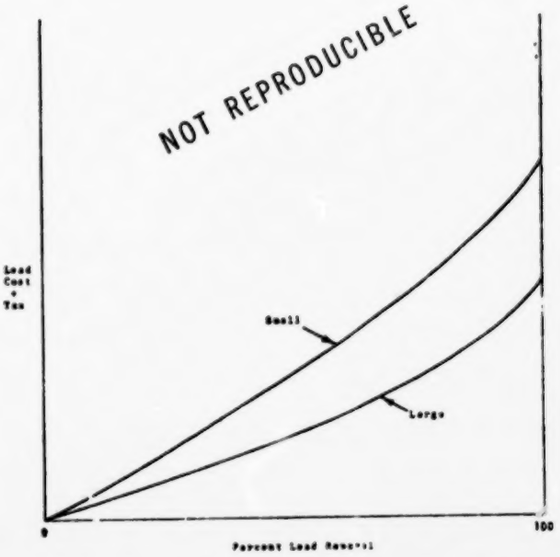

Figure 4-1. Lead Removal Versus Lead Cost for Two Typical Refineries

The tax on lead will not ensure an expected maximum of lead in gasoline for any individual refiner. The only way to establish such a maximum is through regulation. It is our belief, however, that tax will bring about the desired lead reduction, on the average, throughout the United States and the tax will, at the same time, give the small refiners an extended lease on life until they can either meet the desired lead level or shift into other marketing areas.

4.5 TAX RATE SUMMARY

Table 19 displays the tax systems and rates recommended for implementation of each EPA lead reduction schedule included in this study.

TABLE 19

TAX RATES FOR SCHEDULES A, O, N, & L

YEARS	SCHEDULE A		SCHEDULE O*	SCHEDULE N*	SCHEDULE L*
	TAX ON LEADED GASOLINE ¢/GAL	TAX CREDIT ON UNLEADED GASOLINE ¢/GAL	TAX ON LEAD $/#	TAX ON LEAD $/#	TAX ON LEAD $/#
1972			0.65	1.15	1.80
1973			0.75	1.45	3.60
1974	1.0	1.5	1.85	2.50	5.00
1975	2.0	1.5	2.45	3.10	10.50
1976	2.0	1.5	2.85	3.50	14.00
1977	2.0	1.5	3.00	3.70	14.00
1978	2.0	2.0	3.15	3.90	14.00
1979	2.0	2.0	3.30	4.10	14.00
1980	2.0	2.0	3.40	4.20	14.00

*0.5 cents/gal credit on unleaded volume after 1973.